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Evidence for a Neoarchean LIP in the Singhbhum craton, eastern India: Implications to Vaalbara supercontinent

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ABSTRACT

We report eight new Pb-Pb baddeleyite ages and paleomagnetic results on a series of hitherto unknown Neoarchean NNE-SSW trending mafic dyke swarms intruding the Paleoarchean basement rocks in the Singhbhum craton, eastern India. Being the most dominant dyke swarms in the region, they occur over the entire Singhbhum craton with an areal distribution extending to about 30,000 km^2. Of the eight dyke samples analysed across the entire dyke swarm, six were emplaced at 2762.4 ± 2.0 Ma (weighted mean of 6 dyke ages), two with similar strike directions, yielded older and younger ages of 2800.2 ± 0.7 Ma and 2752.0 ± 0.9 Ma respectively. The older 2800.2 ± 0.7 Ma dyke event appears to be coeval with several other magmatic events reported earlier from the Singhbhum craton. Emplacement of dacite tuffs within the Malaigiri basin, on the southern margin of the craton, the Budhapal and Rengali granite from the south-western and southern parts of the craton, along with the Temperkola granite activity and associated acid volcanics in the western part of the craton, and perhaps the Mayurbhanj granite (fine-grained phase) are also contemporaneous, suggesting a fairly wide spread thermal event in the region at this time.

Well defined craton-wide magmatic events contemporaneous to the 2762.4 ± 2.0 Ma Singhbhum dyke activity have been reported from the Pilbara. The younger 2752.0 ± 0.9 Ma age dyke event occurring in the Singhbhum is also know from the eastern Pilbara. An older event at 2783 ± 1.2 Ma (Gaborone-Kanye-Plantation Porphyry-Derdepoort-Modipe episode) was identified in the Kaapvaal craton. Comparison of paleomagnetic data obtained on the Singhbhum Neoarchean dyke swarms with the Pilbara and Kaapvaal data, show all these continents were located at steep latitudes and could have been proximal to each other during this time. If Pilbara and Kaapvaal formed supercraton Vaalbara during the Neoarchean time, we propose Singhbhum with similar Archean geology could also have had its ancestry in the same supercraton.

1. Introduction

Precise geochronology on mafic dyke swarms in conjunction with paleomagnetism provides first-order information necessary for identifying large igneous provinces, for paleoreconstruction of crustal blocks and for revealing the history of supercontinent formation and break-up. As in many Archean blocks mafic dyke swarms are widespread in the Singhbhum craton too, and are known as 'newer dolerites' in the literature (Saha et al., 1973; Saha, 1994). Several K-Ar whole rock age determinations have been attempted on these dyke swarms, which vary appreciably within and between swarms and range from 2144 Ma to 950 Ma (Sarkar et al., 1969; Sarkar and Saha, 1977 and Mallik and Sarkar, 1994). A distinctly older Rb-Sr whole rock isochron age of 2613 ± 177 Ma (Roy et al., 2004) was reported for a NNE-SSW trending ultramafic dyke from the northern part of the craton. A Pb-Pb baddeleyite age of 1765.3 ± 1 Ma was recently reported for one of these dyke swarms with a NW trend (Shankar et al., 2014). Although these age determinations have shown that most of the "newer" dolerite swarms are Proterozoic in age and at least one of these could be Neoarchean, it is not clear whether the large spread in the measured ages from Mesoproterozoic to Neoarchean is real or due to inherent limitations of the dating methods (K-Ar and Rb-Sr) when applied to Proterozoic rocks.

U-Pb age determination to ~0.1% precision on mafic rocks has been possible mainly by the analysis of baddeleyite (ZrO_2) found as a common accessory mineral in them. Baddeleyite generally

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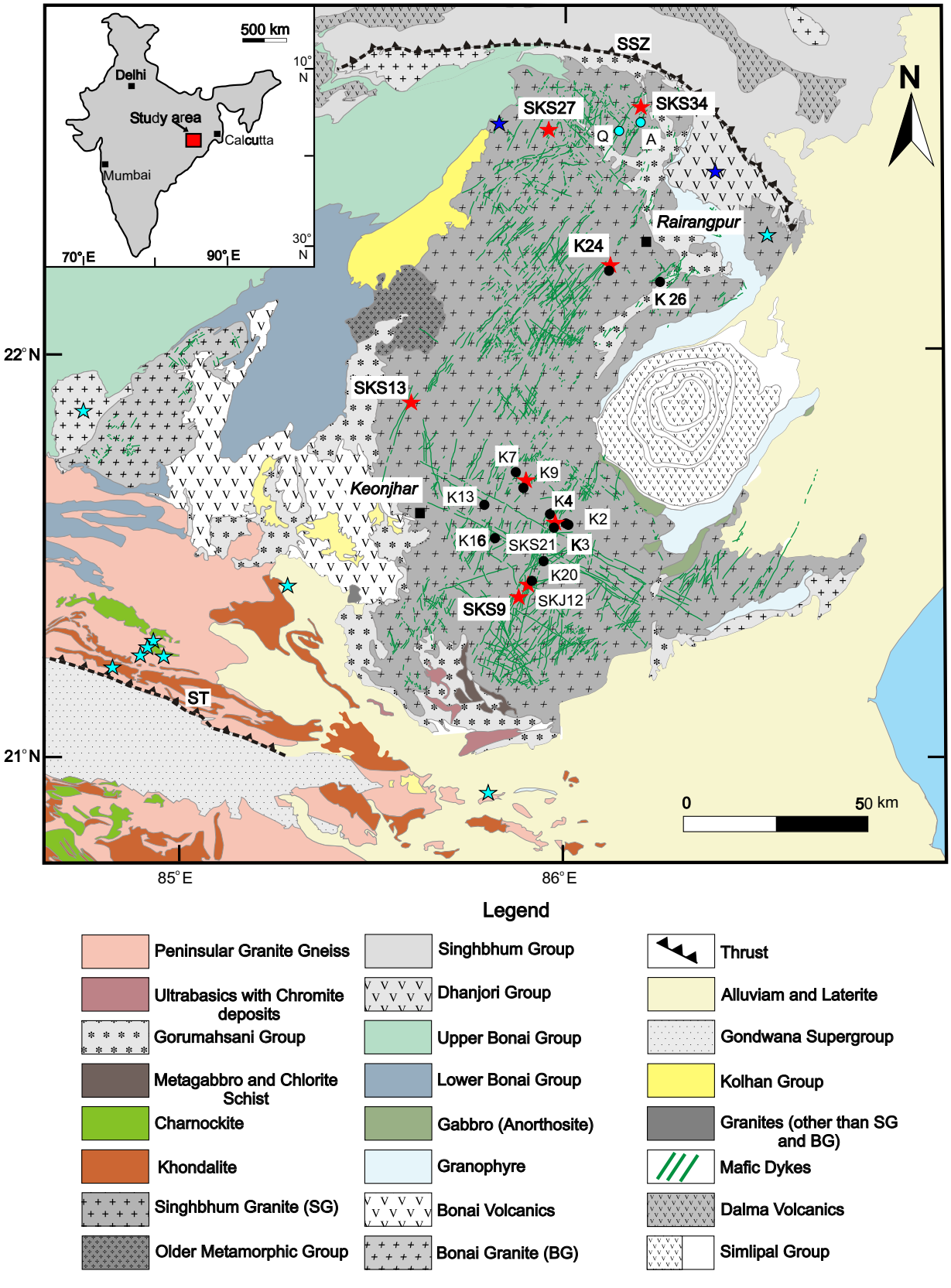

Fig. 1. Simplified geological map of Singhbhum craton (modified after geological quadrangle maps published by Geological survey of India: 73B(2005), 73C(2008), 73F(2008), 73G(1991), 73H(1985), 73 J(1998), 73 K(1998), 73L(1996)). Distribution of dykes traced after google earth satellite images. Black solid circles indicate the locations of paleomagnetic samples from present study, Cyan blue solid circles indicate the locations of paleomagnetic samples from Verma and Prasad (1974), red stars indicate the locations of dated dyke samples (present study), Cyan blue and Blue stars indicate the locations of previously published U-Pb/Pb-Pb (Zircon) (Nelson et al., 2014; Misra et al., 1999; Bandyopadhyay et al., 2001) and Rb-Sr whole rock (Roy et al., 2004) Pb-Pb whole rock (Misra and Johnson, 2005) geochronology sites respectively. SSZ: Singhbhum Shear Zone; ST: Sukinda Thrust. Inset shows the location of the study area in India. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)